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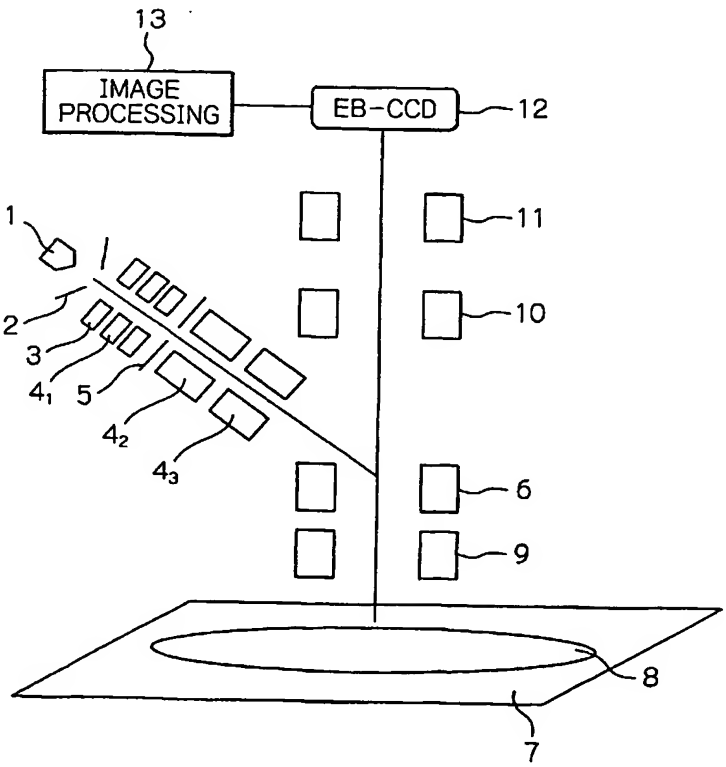
*[Continued on next page]*

(54) Title: MAPPING-PROJECTION-TYPE ELECTRON BEAM APPARATUS FOR INSPECTING SAMPLE BY USING ELECTRONS REFLECTED FROM THE SAMPLE




(57) Abstract: An apparatus capable of detecting defects of a pattern on a sample with high accuracy and reliability and at a high throughput, and a semiconductor manufacturing method using the same are provided. The electron beam apparatus is a mapping-projection-type electron beam apparatus for observing or evaluating a surface of the sample by irradiating the sample with a primary electron beam and forming on a detector an image of reflected electrons emitted from the sample. An electron impact-type detector such as an electron impact-type CCD or an electron impact-type TDI is used as the detector for detecting the reflected electrons. The reflected electrons are selectively detected from an energy difference between the reflected electrons and secondary electrons emitted from the sample. To eliminate charge-up caused on the sample surface by irradiation with the primary electron beam, the surface of the sample is covered with a cover placed above the sample and a gas is supplied to the space above the sample covered with the cover. The gas is brought into contact with the sample surface to reduce charge-up on the sample surface.

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# INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01J37/244 G01N23/203 H01L21/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01J G01N H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | WO 99/46798 A (HITACHI LTD ;KUDO TOMOHIRO (JP); EZUMI MAKOTO (JP); OSE YOICHI (JP) 16 September 1999 (1999-09-16) figures 1,4; example 4 | 1-5,11 |
| X | EP 0 949 653 A (HITACHI INSTRUMENTS ENG ;HITACHI SCIENCE SYSTEMS LTD (JP); HITACHI) 13 October 1999 (1999-10-13) paragraphs '0110!, '0111!; claim 2; figure 10 | 1-5,11 |
| A | PATENT ABSTRACTS OF JAPAN vol. 2002, no. 09, 4 September 2002 (2002-09-04) & JP 2002 141013 A (HITACHI LTD), 17 May 2002 (2002-05-17) abstract; figure | 1-5,11 |

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 30 July 2004 | 06.08.04 |

| Name and mailing address of the ISA | Authorized officer |
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| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Wilhelm, J |

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International Application No
PCT/JP2004/000711

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | ANONYMOUS: "Electron Energy Discriminator for Wafer Chip Testing. November 1980." IBM TECHNICAL DISCLOSURE BULLETIN, vol. 23, no. 6, 1 November 1980 (1980-11-01), pages 2288-2290, XP002280584 New York, US the whole document | 1-5,11 |
| X | WO 00/72355 A (ADLER DAVID ; KLA TENCOR CORP (US); VENEKLASEN LEE (US)) 30 November 2000 (2000-11-30) | 6-9, 12-15 |
| Y | page 18, lines 3-14; claims 20,21 | 10 |
| Y | ZHU W ET AL: "LARGE CURRENT DENSITY FROM CARBON NANOTUBE FIELD EMITTERS" APPLIED PHYSICS LETTERS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 75, no. 6, 9 August 1999 (1999-08-09), pages 873-875, XP000877793 ISSN: 0003-6951 the whole document | 10 |

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/000711

## Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5,11

   Mapping device with energy discriminator for reflected primary electrons

2. claims: 6-10, 12-15

   Mapping device using gas to neutralise surface charge

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/JP2004/000711

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 9946798 A | 16-09-1999 | WO 9946798 A1 | 16-09-1999 |
| | | US 2003127604 A1 | 10-07-2003 |
| | | US 2004089805 A1 | 13-05-2004 |
| EP 0949653 A | 13-10-1999 | JP 2911281 B2 | 23-06-1999 |
| | | JP 5151924 A | 18-06-1993 |
| | | JP 2817072 B2 | 27-10-1998 |
| | | JP 5151926 A | 18-06-1993 |
| | | JP 2789399 B2 | 20-08-1998 |
| | | JP 5151927 A | 18-06-1993 |
| | | EP 0949653 A2 | 13-10-1999 |
| | | EP 0810629 A1 | 03-12-1997 |
| | | DE 69224506 D1 | 02-04-1998 |
| | | DE 69224506 T2 | 01-10-1998 |
| | | DE 69231213 D1 | 03-08-2000 |
| | | DE 69231213 T2 | 01-03-2001 |
| | | EP 0548573 A2 | 30-06-1993 |
| | | US 5412209 A | 02-05-1995 |
| JP 2002141013 A | 17-05-2002 | NONE | |
| WO 0072355 A | 30-11-2000 | US 6087659 A | 11-07-2000 |
| | | US 6586733 B1 | 01-07-2003 |
| | | EP 1183707 A1 | 06-03-2002 |
| | | JP 2003500821 T | 07-01-2003 |
| | | WO 0072355 A1 | 30-11-2000 |
| | | US 2004000642 A1 | 01-01-2004 |
| | | US 2002104964 A1 | 08-08-2002 |
| | | US 2003205669 A1 | 06-11-2003 |